

# The eXtensible Tactical C4I Framework (XTCF)

LCDR Mark V. Glover, USN  
SSC San Diego

## BACKGROUND

The Department of Defense has embarked on a major effort to transform the management of information to enhance operational decision-making, improve combat operations, and realize intelligence advantages. This new, net-centric approach will incorporate network and communications enhancements to support operational users at all levels. A key aspect is making reliable data equally available to users at all levels, from headquarters to the "edge" of the network.

The current approach to command and control of operational forces is based on using the Common Operating Environment (COE) to provide a set of common services and adding mission-specific applications. The Global Command and Control System (GCCS), which is the present Joint command and control (C<sup>2</sup>) system, allows Operational Commanders to maintain dominant battlefield awareness through a fused, near-real-time picture of the battlespace. GCCS provides Operational Commanders with integrated imagery and intelligence, situational awareness, indications and warnings, collaborative planning, course-of-action development, and intelligence mission support. GCCS consists of hardware, software, procedures, standards, and interfaces for connectivity worldwide at all levels of command, and it supports and integrates a wide assortment of mission-critical, joint, service, and site-unique applications, databases, and office-automation tools.

A key capability in GCCS is the Tactical Management System (TMS). TMS is the tactical database management and correlation engine for COE-based systems including GCCS, the Maritime variant (GCCS-M), the Army variant (GCCS-A) and Intelligence Analysis System (IAS), and the Air Force Theater Battle Management Core Systems (TBMCS). TMS facilitates the ability of command and control systems to receive, display, correlate, fuse, and maintain locational information on friendly, hostile, and neutral land, sea, and air forces and integrate it with available intelligence and environmental information.

The current TMS implementation is based on a client-server architecture that provides data replication and synchronization services across a multi-layered network distribution topology. The TMS database consists of a large number of pre-defined track types, each with rules for correlation, association, and data field promotion. TMS also serves as a tactical event notifier that allows mission applications to register for and receive track update, change, merge, and delete events in order to provide operational users with a current tactical track picture.

## ABSTRACT

*This paper describes a development project for the Office of Naval Research (ONR) to provide a new framework for integrating current and emerging tactical data sources seamlessly. The eXtensible Tactical Command, Control, Communications, Computers, and Intelligence (C<sup>4</sup>I) Framework (XTCF) will transform software development in the next generation of command and control tactical data management services. XTCF will provide a common information management framework that will enable multiple data sources, transformation services, analysis tools, and data management services to cooperate in producing a common tactical information network service.*

## XTCF OBJECTIVES (A TRANSFORMATIONAL APPROACH)

The eXtensible Tactical Command, Control, Communications, Computers, and Intelligence (C<sup>4</sup>I) Framework (XTCF) will transform software development in the next generation of command and control tactical data management services. XTCF is providing a Service Oriented Architecture (SOA) to field new data management, correlation, and visualization tools rapidly in a dynamic warfare environment. XTCF will be open and extensible for "plug-in" capabilities that can perform tactical management functions with current and future (i.e., not yet developed or operational) data types and sources. XTCF accomplishes the following objectives:

- Establish a data management framework that enables the integration of new data sources in an operationally relevant timeframe without extensive re-engineering.
- Leverage the data management framework to assist in developing new solutions for existing and new common picture data sources. These solutions will provide both plug-in data representations and plug-in correlation mechanisms for a multi-source picture.
- Improve situational awareness by removing the current limit on the number of tracks and reports and by providing access to larger track histories.

These objectives facilitate integration of intelligence, surveillance, and reconnaissance (ISR) data sources such as signals intelligence (SIGINT), electronic intelligence (ELINT), imagery intelligence (IMINT), measurement and signature intelligence (MASINT), acoustic intelligence (ACINT), tactical digital information link (TADIL or "Link"), and moving-target indicator (MTI) into the common picture without extensive re-engineering. This new, open, and extensible architecture is interoperable with current fielded systems and will provide a framework for integrating current and emerging tactical data sources seamlessly.

Additionally, XTCF will accomplish these objectives by providing a common information management framework that will enable multiple data sources, transformation services, analysis tools, and data management services to cooperate in producing a common tactical information network service. The framework will include the ability to install and activate at runtime new data sources, new data storage agents, new correlation services, new information distribution services, new information query services, and other value-added services. XTCF incorporates these services and tools into the framework as plug-ins. A plug-in may be a group of software components or a single software component. The framework allows new data source developers to take advantage of an existing infrastructure and concentrate on the software that is specific to their applications.

## PROJECT SCOPE

XTCF is a development project for the Office of Naval Research (ONR) as part of the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC). The XTCF Technology Transition Agreement between the Navy Global Command and Control Systems–Maritime (GCCS–M) Program Office (PMW-157) and ONR states that the "XTCF project will deliver a data management framework that enables more rapid and timely technical and developmental exploitation of

emerging complex and heterogeneous data sources for the next-generation common picture." XTCF will permit seamless integration of current and new data sources into the common picture without the extensive re-engineering required today. Using XTCF and associated plug-ins will enhance command and control performance within tactical scenarios such as:

- Combat identification and tracking in a dynamic air-warfare battle problem using visual, radar, and SIGINT data sources in an integrated data management and display environment.
- Time-critical land-attack targeting using MTI, SIGINT, IMINT, and MASINT to provide an integrated picture.
- Increased tactical-data throughput using the evolving Integrated Broadcast Service (IBS), the Tactical Data Information Exchange System-B (TADIXS-B), and enhanced data storage capacity.
- Incorporation of existing SIGINT analysis tools such as the Generic Area Limitation Environment (GALE)-Lite or the Analyst Support Architecture (ASA) that are developed primarily to support sensor signal processing.
- Distributed access to tactical repositories formerly restricted to a local area network (LAN) environment.

### Three-Tier Information Architecture

The XTCF software architecture supports a three-tier tactical information model. Tactical information can enter the system as a report, a track, or an entity. A report can consist of parametric measurements (such as those in a typical ELINT report) combined with location measurements (such as an area of uncertainty or line of bearing) and a time interval. A report can also contain other properties of the observed object such as identifiers or classification information. The correlation process combines reports of the same type to form tracks. Under the three-tier information architecture, tracks are really clusters of reports from a given sensor system that are all observations of the same entity. Multi-source correlation associates tracks from different sensors or reporting systems with each other and with the specific entities that they represent. Entities can be any militarily significant objects that the commander must deal with, such as platforms, masses of troops, targeted sites, or friendly assets.

The XTCF framework will permit adding new report sources and report types to an existing system. These new report types may have a corresponding new track type or they may be reports for an existing track type. Similarly, a new track type can use an existing type of report. All track types are candidates for entity association.

### Separation of Responsibilities

A plug-in architecture such as XTCF repartitions the responsibilities of the developer and system integrator. In fact, the developer becomes a component developer, and the system integrator now takes on many of the developer's concerns regarding intercomponent communication. The developer is responsible for what data his module produces and/or consumes; the integrator is responsible for certifying components for installation and the data flow necessary for the correct functioning of the system. The component developer now can focus on the specific task at hand, rather than with system issues. This separation of responsibilities lowers the barriers to entry for component developers and speeds the injection of new technology.

### Principle Core Enterprise Services

XTCF will run across multiple host platform environments. As such, XTCF development will leverage the following core technologies to form the foundation for the XTCF environment:

- Messaging Services (Publish/Subscribe)
- Extensible Markup Language (XML)
- XML Schema
- Universal Discovery and Description Interface (UDDI)
- Simple Object Access Protocol (SOAP)
- Web Services Description Language (WSDL)
- Lightweight Directory Access Protocol (LDAP)

### Principal C<sup>2</sup> Components

The following XTCF software components support the three-tier architecture concept:

- Report Manager(s)
- Track Correlator(s)
- Track Manager(s)
- Entity Correlator(s)
- Entity Manager

### Distributed Concepts

The principal purpose of an XTCF-based system is to provide an SOA. This objective implies that XTCF will consist of several processes running on many machines within a network. Each process will consist of one or more loosely coupled software components that run within the XTCF runtime environment. This environment provides a minimal infrastructure for XTCF components to co-exist, while sharing information and common services without interfering with each other. A standard network timing protocol will facilitate temporal synchronization of the processes. Each event can have a tag to note time of generation.

### The Messaging Service

The backbone of XTCF will consist of a message publication facility that allows one component running in one process to send messages to another component running in another process. The XTCF Messaging Service (XMS) is one of the principal software components of the framework. XMS will provide asynchronous, reliable message exchange between XTCF components. In the Java environment, XMS will build on the JMS messaging specification for inter-process messaging.

## OPERATIONAL CONCEPT

Naval, joint, and coalition operations increasingly use a broad variety of organic and non-organic ISR data sources including traditional "INTS" (SIGINT, MASINT, IMINT, HUMINT, etc.), Tactical Data Information Links (TADILs), and reference databases. This continually increasing volume of data stresses today's Common Operational Picture (COP) architecture to its limits. The new net-centric approach allows naval, joint, and coalition forces to operate in a networked information domain that has the capability to share and exchange information among geographically distributed forces including sensors, decision-makers, and

shooters. This domain provides access to assured information whenever and wherever needed. This coherent view of the battlespace, from space to sea bed, will provide the Information Superiority required in today's dynamic environment.

Operational payoffs will include the following:

- Improving a Commander's situational analysis, awareness, and planning by leveraging the concepts of Smart Push (time-sensitive situational awareness and survival data where publishers provide streams of all available data in selected categories) and Intelligent Pull (where user queries initiate information delivery)
- Enhancing interoperability by eliminating the current Common Operational Picture maritime track-centric approach and extending wide-area network (WAN) access to operationally relevant, non-track-centric, non-geographically referenced data
- Increasing "speed-to-capability"
- Allowing tailoring of information on a plug-and-play basis to facilitate customizing and delivering the essential information and data services critical to a specified mission area
- Providing distributed access to tactical data repositories (formerly restricted to a LAN environment) to widely dispersed forces
- Making timely "raw" and processed multi-intelligence (multi-INT) data available to users
- Eliminating unique Department of Defense (DoD) data synchronization and distribution issues:
  - Data duplication at nodes—creating unnecessary processing
  - Data ringing
  - Event-based "dumb push" of sensor events—wasting needed network capacity
- Increasing the capacity of disadvantaged users to access tactically relevant data

Ultimately, these operational payoffs will realize the overall objective of a relevant, consistent, and secure representation of tactical geo-spatial data that ensures a common basis of decision-supporting information.



**LCDR Mark V. Glover,  
USN**

MS, Information Technology Management, Naval Postgraduate School, 1996; MS in Computer Science, Naval Postgraduate School, 2001

Current Research: Project Manager for the eXtensible Tactical C4I Framework, directing the planning, scheduling, budgeting, engineering, and execution of this project, which is designed to provide infrastructure for the next-generation common operating picture.